Federal Land Assistance, Management and Enhancement (FLAME) Act Suppression Expenditures for Interior and Agriculture Agencies:

May 2011 Forecasts for Fiscal Year 2011

Report Date: April 15, 2011

Executive Summary

The USDA Forest Service is forecast to spend, with 80% confidence, between $1,218m and $1,564m in Fiscal Year (FY) 2011, while the agencies of the Department of the Interior are forecast to spend, with 80% confidence, between $271m and $457m. The Forest Service forecast includes $402m in contributions to the agency's Cost Pool and National Aviation Assets. The median forecast for the Forest Service is $1,380m, while the median forecast for Interior is $364m. Excluding the Cost Pool and National Aviation Assets, the Forest Service's median forecast for FY 2011 has declined about 5% from the September 2010 and March 2011 forecast levels for FY 2011, primarily resulting from ongoing above-average moisture levels in most western regions outside of Region 5. The expenditures of Region 5 are forecasted to be above historical averages (current Pacific Ocean temperature and pressure indices are correlated with higher fiscal year spending in Region 5). Interior agency expenditures are somewhat higher in this May 2011 forecast than those projected in March 2011 but are nearly identical to the forecast for FY 2011 made in September 2010. These variations across horizons are due to changes in climatic conditions as well as model input data.

Overview

The Rocky Mountain Research Station (RMRS) has provided monthly forecasts of annual FS suppression expenditures since FY 1998 and annual DOI suppression expenditures since FY 2005. These updated monthly forecasts are provided during the fire season months of June through September. In addition, starting in FY 2003, the RMRS and the Southern Research Station (SRS) have collaborated to provide "early warning" forecasts of annual Forest Service suppression expenditures in the fall and spring of the fiscal year.

With the passage of the FLAME Act in FY 2009, both the Forest Service and the Department of the Interior are required to produce forecasts of annual suppression expenditures three times during each fiscal year: March, May, and July, with a September outlook for the next fiscal year required when the next fiscal year budget is not approved by Congress and the President by that date. The current report was produced in mid-April, in time for review and in compliance with the May due date for this forecast for FY 2011.

Modeling

Modeling Framework for the May 2011 Forest Service Expenditure Forecasts

To meet the statutory requirements of the FLAME Act, the Forest Service developed statistical models based on peer reviewed research[1,2]. These models have been developed for several forecast horizons and are generally specified as a system of equations. Each of the six equations contained in the current modeling system represents a statistical relationship between historical cost and a set of predictor variables for a particular Forest Service region or the sum of two regions. These equations are estimated simultaneously as a system but allowed to solve without constraints across equations within the system. For this reason, the estimation procedure is called Seemingly Unrelated Regression (SUR).

For this forecast, similar to the forecasts issued in the Fall of 2009 for FY 2010, the Spring of 2010 for FY 2010, September of 2010 for FY 2011, and March of 2011 for FY 2011, equations are specified for the following regions or regional aggregates: (i) Region 1 plus Region 4, (ii) Region 2 plus Region 3, (iii) Region 5, (iv) Region 6, (v) Region 8 plus Region 9, and (vi) Region 10 plus the National Interagency Fire Center, Washington Office, and research stations, which we label in this report as "RFS." The statistical relationships that we have identified with extensive research effort relate spending in the coming fiscal year to lagged measures of drought (Palmer indices), ocean temperatures (the Niño-3 sea surface temperature anomaly), ocean pressure indices (Pacific Decadal Oscillation, Atlantic Multidecadal Oscillation, and the Southern Oscillation), and a forecast of the monthly average Niño-3 sea surface temperature anomaly for the remainder of the fiscal year. The equation for Region 5 includes a time trend. Equation estimates are shown in Table A1, which appears in an Appendix to this report.

Forecasts are made for region-level costs that exclude Cost Pool and National Aviation Asset charges, which are fixed components added back to the costs for the Region 10 and RFS aggregate. Data for modeling are annual fiscal year totals of expenditures, and they range from 1995 to 2010, the only years for which consistent region-level data can be assembled. To erase the effects of general price inflation, all costs are deflated to the value of a dollar in 2004 using the gross domestic product deflator—that is, models are estimated and costs are forecast in "real" dollar terms. After the forecast, we adjust the forecast values to put them in current dollars. SUR estimates allow for more precise identification of statistical relationships by using the correlations in estimation errors. When generating a forecast distribution (see Figure 1), we randomly sample from equation error and coefficient distributions in ways that account for the uncertainties in our forecast. These Monte Carlo forecasts, which are repeated 50,000 times for the Forest Service forecast, do not produce a precise estimate. Rather, they generate a

[1] Prestemon, J.P., K.L. Abt, and K. Gebert. 2008. Suppression cost forecasts in advance of wildfire seasons. Forest Science 54(4):381-396.

[2] Abt, K.L., J.P. Prestemon, and K. Gebert. 2009. Wildfire suppression cost forecasts for the US Forest Service. Journal of Forestry 107(4):173-178.

distribution of estimates. This distribution can be summarized in many ways. In our forecasts, we produce a forecast density distribution, a table reporting a median forecast and the lower and upper bounds of likely observed costs, a table of not-to-exceed costs by probability levels, and a description of where the median forecast value falls within the observed historical costs for other years, in real dollar terms.

Model fitness is reported in the Appendix of this report and is described both graphically (Figure A1) and tabularly (Table A2). The graph shows how the May 2011 model out-of-sample forecasts (produced by dropping the observation of the forecast year, and doing this iteratively over the historical data, a technique sometimes termed "jackknife") compare with observed expenditures for the Forest Service as well as forecasts produced by the September 2010 Out-Year Forecast Model and the March 2011 Current Year Forecast Model. Table A2 shows that the root mean squared error of the model used in this May 2011 forecast, when applied to the 1995-2010 period, is $210m and that it has a small positive bias, tending to over-forecast by about $10m (1.43%). The model has a mean absolute percent error of about 28%, meaning that the typical forecast averaged 28% above or below expenditures actually incurred during the 1995-2010 period. Finally, this model correctly predicted the direction of change in emergency suppression expenditures by the Forest Service 94% of the time—that is, in all but one of the years, 1995-2010. It should be noted that the median forecast is projected to be substantially higher than the observed expenditure for FY 2010 (Figure A1).

Modeling Framework for the May 2011 Department of the Interior Expenditure Forecast

The development of a forecast model for the Department of the Interior (DOI) was constrained by a lack of detailed regional expenditure data for the Department. The only DOI suppression expenditure data currently available for developing this forecast were annual DOI suppression expenditures for FY 1985 to FY 2010. The lack of geographic specificity in the data and the low number of observations led to a parsimonious modeling framework, wherein annual DOI suppression expenditures are forecast as a function of forecast Forest Service emergency suppression expenditures. Specifically, we estimate a single DOI cost equation that relates the observed DOI expenditures to forecast Forest Service expenditures. In this May 2011 model, we related DOI expenditures to the May 2011 SUR model forecasts of the Forest Service, 1995-2010 (see the previous section of this report). For the FY 2011 forecast, we use the single value of the Forest Service FY 2011 forecast with the highest likelihood of occurrence, the "point estimate." The point estimate is the forecast produced by using the exact model parameter estimates shown in Table A1.

Few variations of the DOI suppression expenditure forecast model were tested—i.e., we tried to include the Westwide March Palmer Drought Severity Index, which added no additional forecast skill over that provided by the Forest Service forecast variable. Hence, that drought measure was not included. Instead, as in the September 2010 Out-Year Forecast Model produced for FY 2011, this May 2011 forecast model for DOI only contains linear and squared terms for the forecast of Forest Service emergency suppression expenditures (Table A3). The

estimated equation explains 75% of the variation ($R^2 = 0.75$) in annual DOI suppression expenditures over the historical time period, 1995-2010.

Model fitness for the May forecast model for DOI is reported in Appendix Table A4. As in the case of the Forest Service May forecast model, the DOI model is evaluated by making jackknife forecasts of DOI expenditures. The May DOI forecast model has a root mean squared error of about $64m, a small bias of about $3.5m (1.32%), a mean absolute percent error in the forecast of about 24%, and a correct prediction of the direction of change in emergency suppression expenditures from the previous year in 75% of the years, 1995-2010. Relevant to this last statistic, the median forecast is projected to be higher than the observed expenditure for FY 2010 (Figure A2).

Results

USDA Forest Service

Fiscal Year 2011 emergency suppression expenditures are forecast to range, with 80% confidence, between $1,218m and $1,564m. The median forecast is $1,380m. These costs include $402 million in Cost Pool and National Aviation Assets, which are added to the Region 10 plus RFS forecasts (Table 1). Uncertainty can be appreciated by examining the forecast probability density (Figure 1) and the not-to-exceed levels at a range of probabilities (Table 2). As Table 2 shows, this model states that there is a 1% chance that Forest Service emergency suppression expenditures, including the Cost Pool and National Aviation Assets, will fall below $1,093m. In contrast, there is a 70% chance that these expenditures will fall below $1,451m.

An analysis of historical real dollar expenditures in emergency suppression contains information about the likely financial magnitude of spending for FY 2011 (Table 3), by Forest Service Region or region aggregate, and in total. An examination of this table reveals some of the regional heterogeneity generating the expected expenditures. Region 5 stands out as the only region that is expected to have costs in line with the upper third (tercile) of expenditures observed over the past 15 years. In contrast, regions 1-4 stand out as having somewhat lower than average costs, when compared with the last 15 years of spending in these locations. Regions 1-4 are also expected to fall in the lower or middle tercile of costs when contrasted with the costs observed since 1977, but all other regions are expected to still be in the upper tercile of the costs observed since 1977.

Department of the Interior

Fiscal Year 2011 emergency suppression expenditures for the DOI are forecast to range, with 80% confidence, from $271m to $457m, with a median forecast of $364m (Table 2). As in the Forest Service forecast, uncertainty surrounding the DOI forecast for FY 2011 can be appreciated by examining the probability density (Figure 2). The 90% confidence band spans $245m to $484m. The median forecast is $1m higher than the median forecast produced by the DOI September Out-Year Forecast model (issued August 31, 2010) and $85m higher than the

March Current Year Forecast Model for DOI. One difference between the May model and the two previous models is the addition of one observation (2010) in the DOI modeling dataset, which led to different parameter estimates, even in the absence of large changes in the Forest Service expenditure forecast for FY 2011.

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Table 1. May 2011 FLAME Act Forecasts of Fiscal Year 2011 Emergency Suppression Expenditures of the USDA Forest Service, by Region and in Total, Current (FY 2011) Dollars

	R 1&4	R 2&3	R 5	R 6	R 8&9	R 10&13	Total
	Millions of 2011 Dollars						
Median	39	39	617	64	61	546	1,380
80% Confidence Lower Limit	22	21	525	31	33	472	1,218
80% Confidence Upper Limit	70	73	708	131	90	621	1,564
90% Confidence Lower Limit	18	18	498	25	25	451	1,173
90% Confidence Upper Limit	83	86	735	159	98	641	1,623
95% Confidence Lower Limit	16	16	475	21	18	433	1,136
95% Confidence Upper Limit	96	99	758	191	105	659	1,678

Note: This table includes the Fiscal Year 2011 WFSU Cost Pool and National Aviation Assets as a fixed charge of $402 million, which is added to the Region 10 + RFS forecast and the agency-wide total.

Table 2. May 2011 FLAME Act Forecasts of Fiscal Year 2011 Emergency Suppression Expenditures of the USDA Forest Service, by Percentiles, Current (FY 2011) Dollars

Probability (%) of Falling Below Indicated Dollar Amount	Realized Amount (Millions of 2011 Dollars)
1	1,093
5	1,173
10	1,218
20	1,273
30	1,313
40	1,347
50	1,380
60	1,413
70	1,451
80	1,496
90	1,564
95	1,623
99	1,747

Note: This table includes the Fiscal Year 2011 WFSU Cost Pool and National Aviation Assets as a fixed charge of $402 million, which is added to the Region 10 + RFS forecast and the agency-wide total.

Table 3. May 2011 FLAME Act Forecasts of Fiscal Year 2011 Emergency Suppression Expenditures of the USDA Forest Service, by Terciles, Current (FY 2011) Dollars

Region or Aggregate	Tercile of Costs Expected, Last 15 Years	Tercile of Costs Expected, Last 34 Years
R 1 + R4	Lower	Lower
R 2 + R3	Lower	Middle
R 5	Upper	Upper
R 6	Middle	Upper
R 8 + R9	Middle	Upper
R 10 + RFS	Middle	Upper
Total	Middle	Upper

Note: Fiscal Year 2011 WFSU Cost Pool and National Aviation Assets charges are assumed to be zero in this and all previous year rankings.

Table 4. May 2011 FLAME Act Forecasts of Fiscal Year 2011 Emergency Suppression Expenditures of the Department of the Interior, Current (FY 2011) Dollars

	Millions of 2011 Dollars
Median Estimate	364
80% Confidence Lower Limit	271
80% Confidence Upper Limit	457
90% Confidence Lower Limit	245
90% Confidence Upper Limit	484
95% Confidence Lower Limit	221
95% Confidence Upper Limit	507

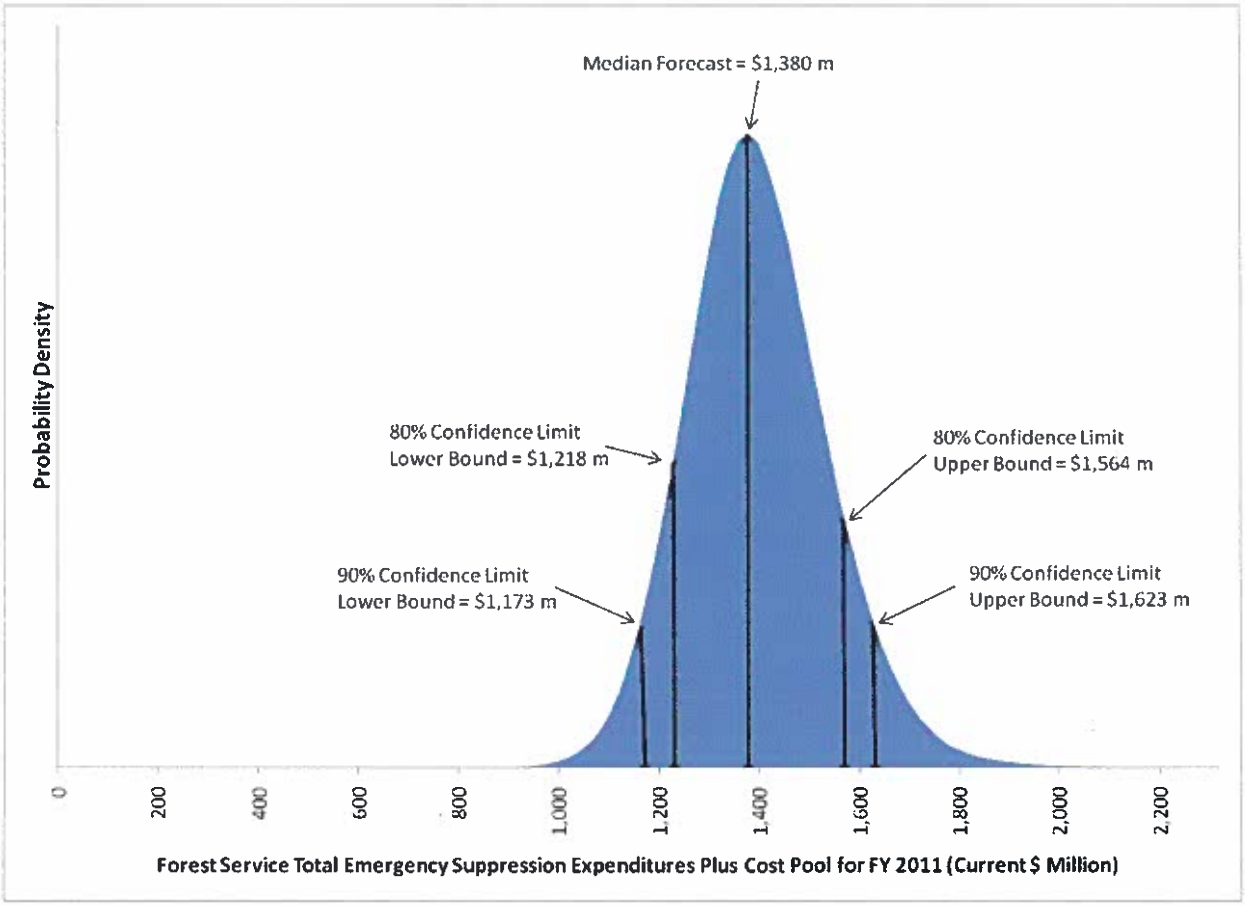

Figure 1. US A Forest Service emergency suppression expenditure forecast probability density, Fiscal Year 2011, May FLAME Act Current Year Forecast Model. Note: The Fiscal Year 2011 WFSU Cost Pool and National Aviation Assets charges are included as a fixed amount of 402 million in this probability density display.

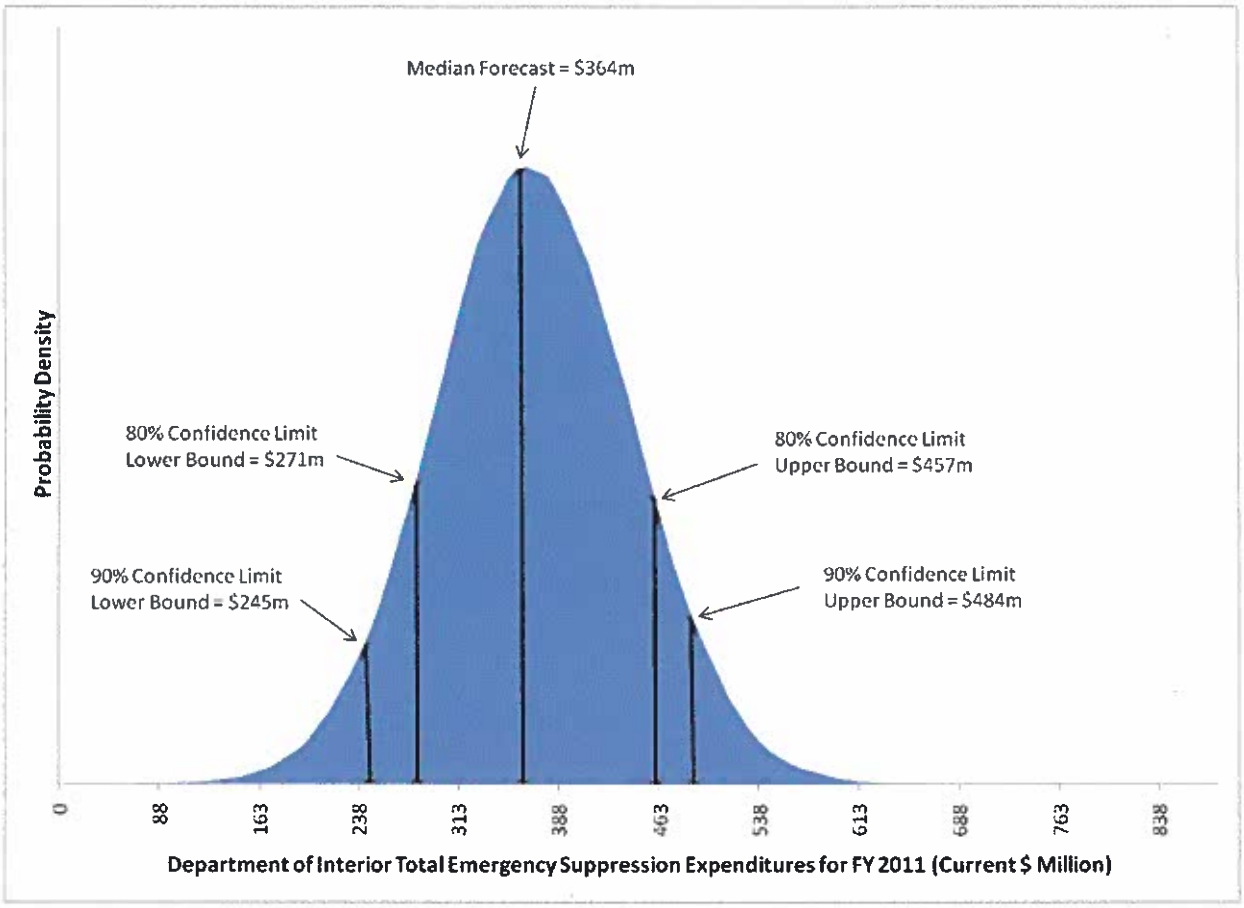

Figure 2. Department of the Interior emergency suppression expenditure forecast probability density, Fiscal Year 2011, May FLAME Act Current Year Forecast Model.

Appendix: Model Estimates and Forecast Evaluation Statistics

Table A1. Seemingly Unrelated Regression Equation Estimates, Forest Service May 2011 Forecast Model

Dependent Variable	Independent Variables	Coefficient	Std. Error	t-Stat.	P-Value	R^2	Durbin-Watson Statistic
Ln(Region 1 + Region 4 Cost)	Constant	17.35	0.14	122.60	0.00	0.77	1.85
	SOI August(t-1)	-0.26	0.06	-4.46	0.00		
	AMO October-February (t-1)	1.88	0.48	3,92	0.00		
	Niño-3 SSTA October (t-1) to February (t) Mean	-0.65	0.10	-6.51	0.00		
	March Palmer H-Index Westwide Mean (t) if < 0	-0.39	0.05	-7.71	0.00		
Ln(Region 2 + Region 3 Cost)	Constant	17.19	0.24	71.27	0.00	0.56	3.03
	SOI August(t-1)	-0.23	0.07	-3.35	0.00		
	Niño-3 SSTA October (t-1) to February (t) Mean	-0.22	0.09	-2.36	0.02		
	R2&R3 Average December Palmer Z-Index (t-1) if < 0	-0.37	0.12	-3.18	0.00		
	March Palmer H-Index Westwide Mean (t)	-0.19	0.05	-3.78	0.00		
Region 5 Cost	Constant	-31,600,000,000	4,800,000,000	-6.59	0.00	0.87	1.61
	Year	16,006,655	2,401,285	6.67	0.00		
	Niño-3 SSTA October (t-1) to February (t) Mean	-95,026,770	11,337,568	-8.38	0.00		
	Pacific Decadal Oscillation Index October (t-1) to February (t) Mean X Niño-3 SSTA October (t-1) to February (t) Mean	51,301,203	10,165,498	5.05	0.00		
	Region 5 September Palmer Z-Index(t-1)	138,000,000	22,606,983	6.09	0.00		
Ln(Region 6 Cost)	Constant	18.02	0.15	122.24	0.00	0.50	2.61
	March Palmer H-Index Westwide Mean (t)	-0.28	0.06	-4.70	0.00		
Region 8 + Region 9 Cost	Constant	44,496,241	4,455,167	9.99	0.00	0.56	2.19
	R8 March Palmer H-Index(t)	-15,932,745	2,797,362	-5.70	0.00		
	Niño-3 SSTA October (t-1) to February (t) Mean	13,620,278	3,953,945	3.44	0.00		

Region 10 + RFS Cost	Constant	104,000,000	19,604,971	5.29	0.00	0.45	2.10
	Region 10 + RFS Cost(t-1)	-0.21	0.13	-1.54	0.13		
	Niño-3 SSTA October (t-1) to February (t) Mean	-26,753,447	9,528,097	-2.81	0.01		
	Pacific Decadal Oscillation Index October (t-1) to February (t) Mean X Niño-3 SSTA October (t-1) to February (t) Mean	13,980,920	8,930,269	1.57	0.12		
	March Palmer H-Index Westwide Mean (t-1)						